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Controlling Salmonella and Campylobacter in poultry

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Birling LABORATORY

Bacteria associated with Poultry

Food microbiology considers the interaction between humans, microorganisms and foods

Impact upon the quality, safety and production of poultry:

- Food spoilage
- Foodborne illness/disease
- Food taints: i.e. white dots caused by *Brochothrix thermosphacta*
- Production of Biofilms
- Probiotics and bio-protective cultures

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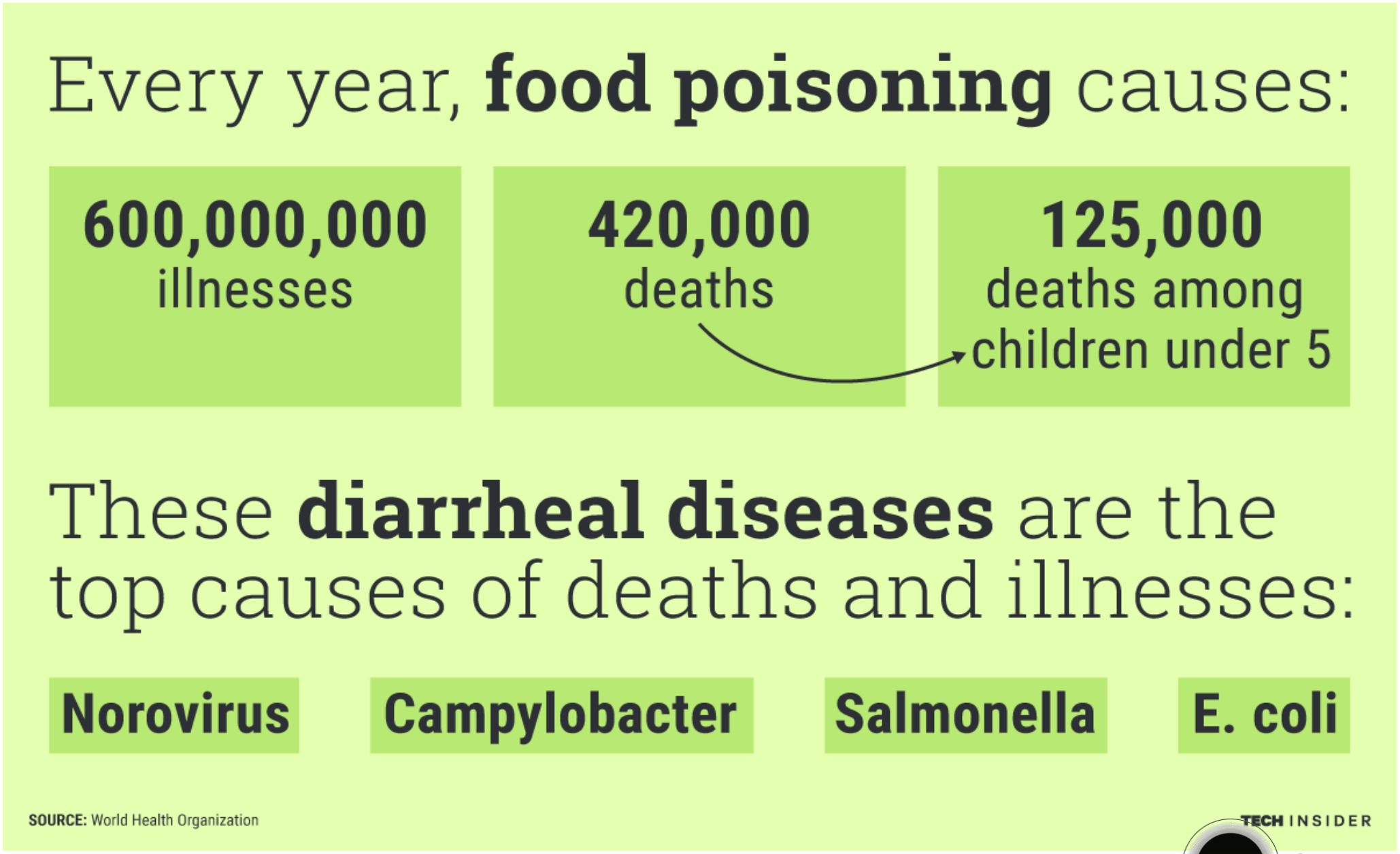

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Enteropathogens associated with chicken

Campylobacter 204:100,000 *(NNDSS; 2019)*

Salmonella 52:100,000 *(NNDSS; 2019)*

Staphylococcus aureus mainly toxin associated in cooked/reheated meals

Bacillus cereus mainly toxin associated in cooked/reheated meals

Clostridium perfingens mainly toxin associated in cooked/reheated meals

Listeria monocytogenes total of 52 cases *(NNDSS; 2019)*

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Verification Points – Poultry PPP

Verification Point	Live Bird Receipt	Evisceration	Carcass Decontamination	Storage, Further Processing and Distribution
Performance target	8-12 h feed withdrawal	No unacceptable carcasses entering the carcass wash	5 ppm FAC pH 5-7 ORP > 650 mV	Carcasses chilled to <7°C within 6 h of stunning, ≤5°C within 12 h and maintained
Outcome	No feed in crop/minimal gut spillage reduces prevalence and numbers of *Salmonella*, *Campylobacter*	Occurs at EV, final inspection. Minimises pressure on CCPs further along the chain	Overall reduction in microbial load during washing/chilling	Chilling supports an overall reduction in microbial load. Minimise pathogenic loads and preserve quality

Source: FSANZ (2016)

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Inside outside washer

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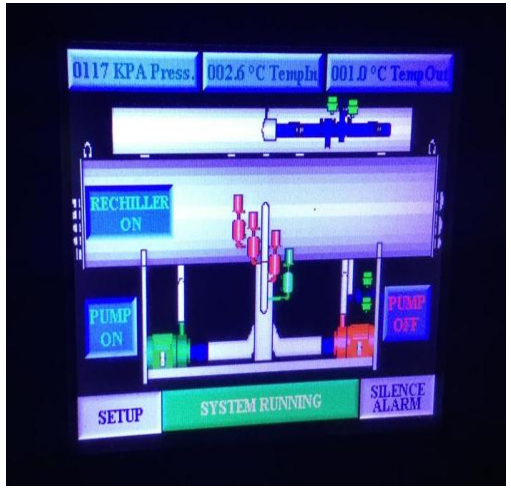
CAT spin chiller



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Salmonella

2nd to *Campylobacter* in cause of foodborne bacterial gastroenteritis

Over 2500 serovars have been identified

- Based on antigenic typing and further discriminated by phage and molecular subtyping techniques
- Serovars Enteritidis (SE) and Typhimurium (ST) of major public health concern from food industry perspective

Found in a wide range of foods/environments, but commonly colonise the intestinal tract of poultry, livestock, wildlife, domestic pets

- Eggs, raw meat/poultry, fresh produce, low moisture foods

Vertical and horizontal transmission in poultry production – through-chain control

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Salmonella Critical Control Points

Chick Processing
-instrument sexing?
-belts
-air

Hatcher
-cross w/pos.

Chick and Bird Transport

Left over From last Flock

Biosecurity
-separation of positive flocks from negative flocks.
-people
-equipment

Field Vaccination
-Equipment
-Field and Hatchery

Vaccine
Medication

Feed & Water

Introduction of new GP Stock

Vertical
-hen to chick
-Via egg shell

Rodents
Insects
People

Spike Male
-introduction
-equipment

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Chemical treatment

Many types of registered organic acid feed additives available on the market.

These additives claim to reduce *Salmonella* in feed or promote LAB growth within the chicken.

Oligosaccharides are complex sugar moleculars i.e. β-glucans.

Prebiotics which stimulate the growth of LAB’s and other probiotics.

Competitive Exclusion

Beneficial ‘good’ bacteria (Probiotics) treatment.

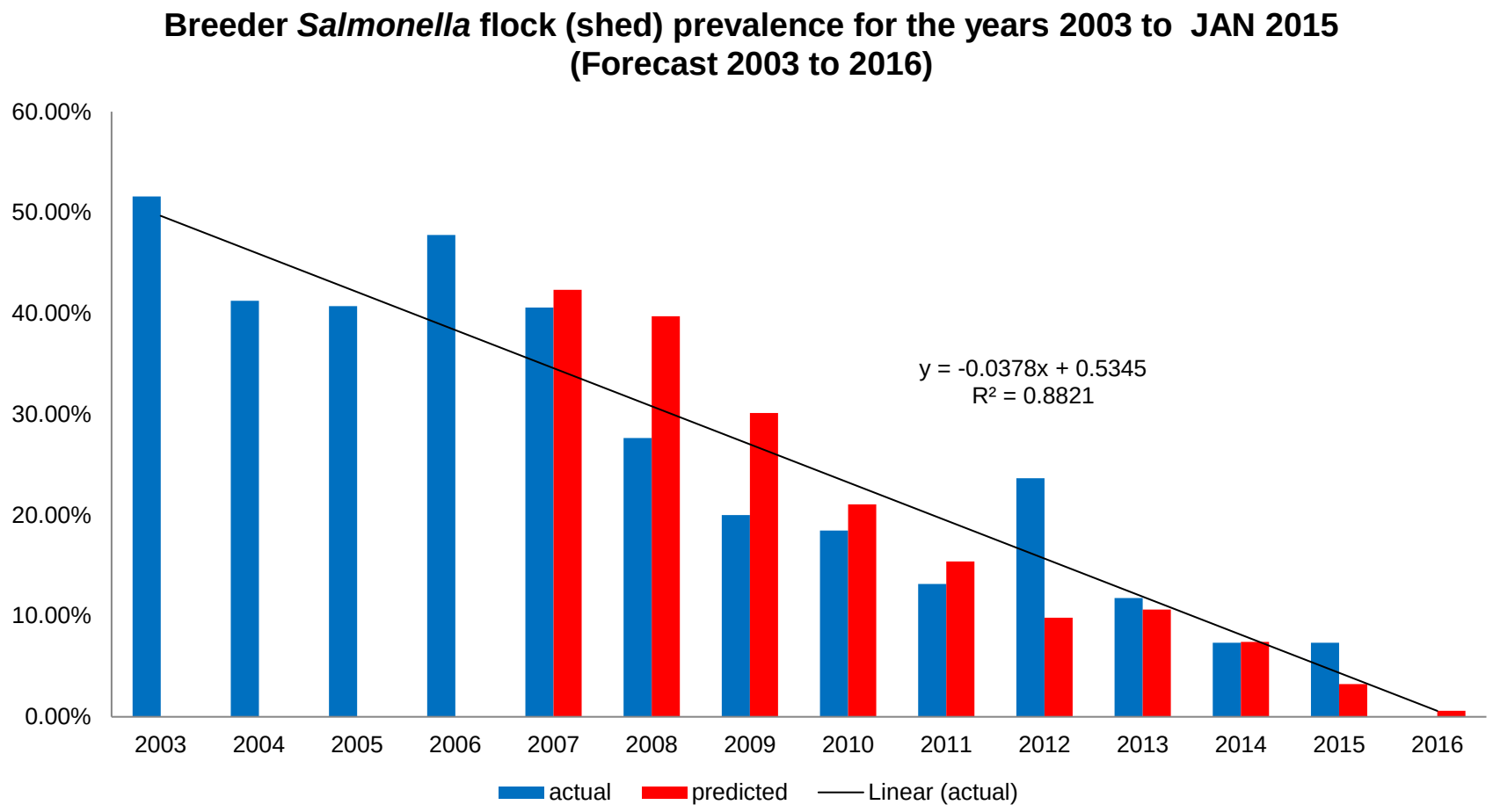
- Direct
  - > Volatile fatty acids
  - > Competition for binding sites and nutrients
  - > Production of antimicrobial substance (i.e. Nisin).
- Indirect
  - > Stimulate immune system
  - > Increase peristalsis

Vaccination

Two types available:

- Killed
  - > Autologus or homologus
    - – Salenvac® used in Europe.
    - – Killed serovars of Enteritidis and Typhimurium (homologus)
    - – Australia same technology but 3 serovars (Typhimurium (B), Mbandaka (C) & Orion (E)) (autologous)
- Attenuated
  - > Predominately *AroA* chromosomal deletion.
    - – Commercially available Enteriditis and Typhimurium.

Birling / Zootechny Sal Vaccine



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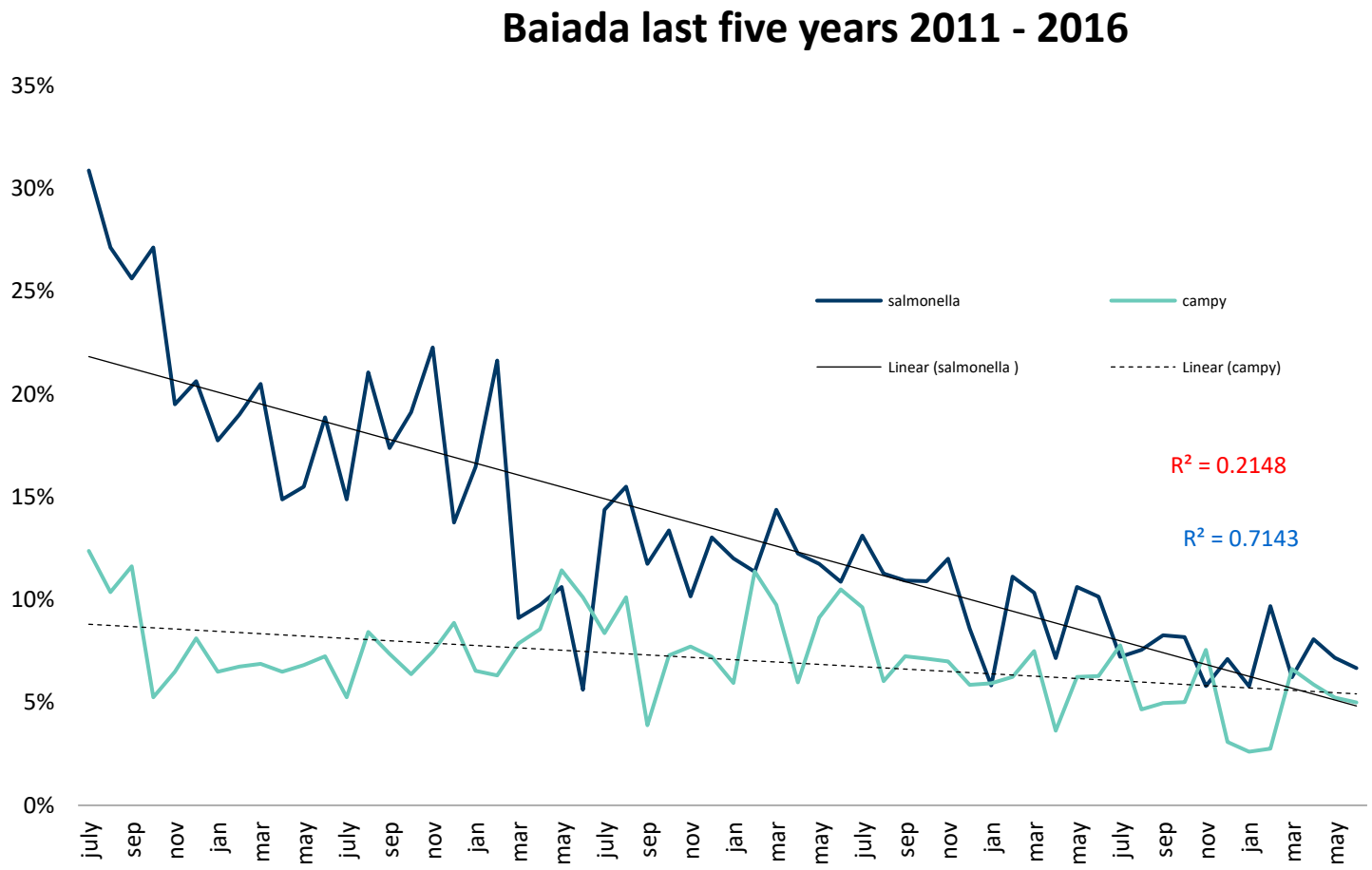
Published data: Carcass prevalence



Campylobacter

C. jejuni and *C. coli* are the leading cause of human foodborne bacterial gastroenteritis worldwide

Campylobacter spp. colonise the intestinal tract of food producing animals

- Inadequate processing and cross-contamination of RTE foods
- Poultry (sporadic infections) and raw/unpasteurised milk (outbreaks)

Well adapted to the avian gut highly prevalent on raw/undercooked poultry

Does not survive well outside of the host

- Capnophilic, microaerobic conditions, 42°C optimum temperature
- Highly sensitive to ambient conditions, refrigeration and freezing

FSANZ, Safe Food QLD, NSW Food Authority – KFSI/process control indicator

- Quantitative limit of < 10,000 cfu/carcass acceptable (based on dose-response models)

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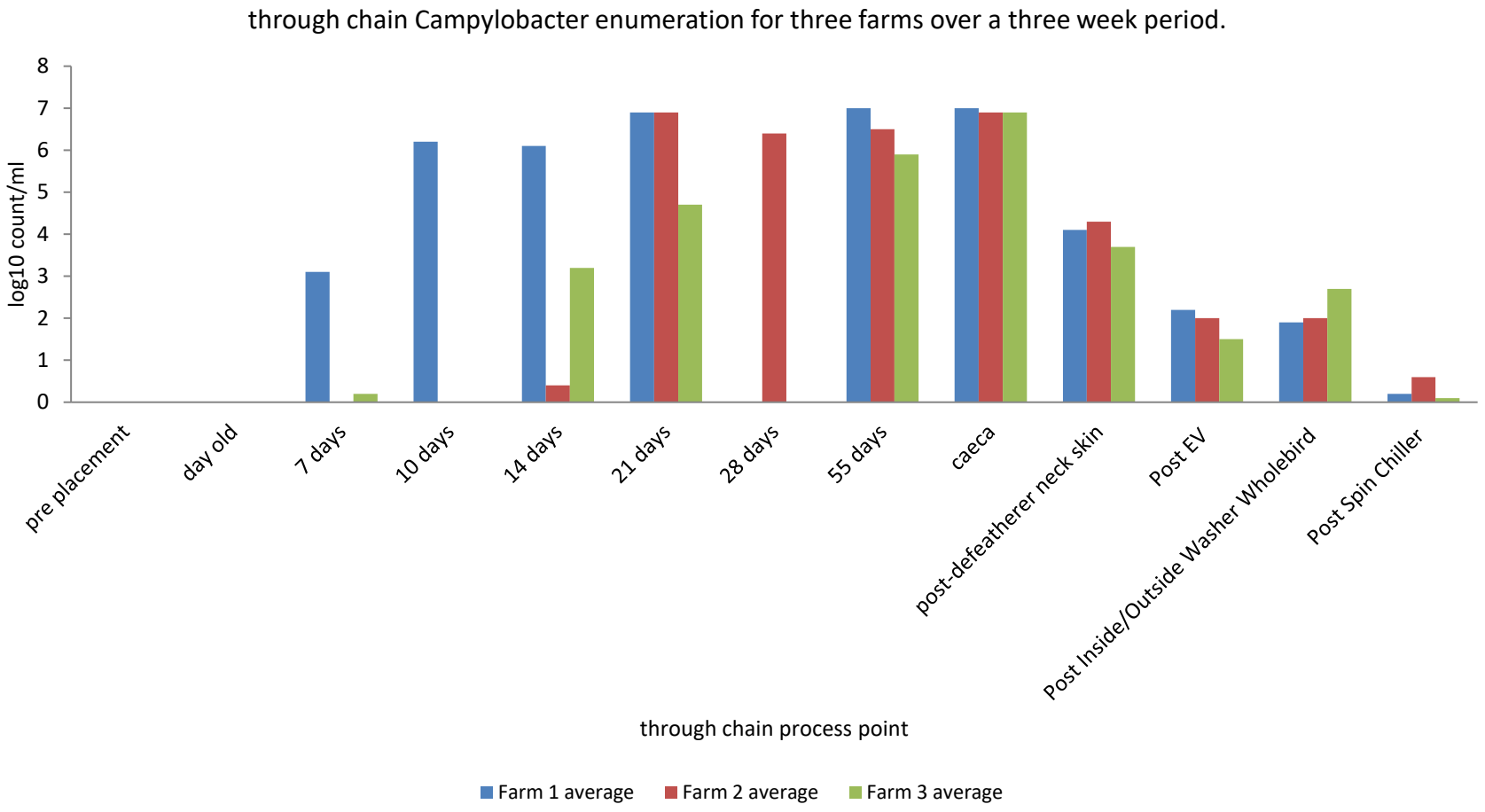
through chain Campylobacter enumeration for three farms over a three week period.
log10 count/ml
8
7
6
5
4
3
2
1
0
pre placement
day old
7 days
10 days
14 days
21 days
28 days
55 days
caeca
post-defeatherer neck skin
Post EV
Post Inside/Outside Washer Wholebird
Post Spin Chiller
through chain process point
Farm 1 average
Farm 2 average
Farm 3 average

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Campylobacter meta-analysis interventional strategies

Intervention	Effect	Reference
Addition of fly-screens to broiler houses	Reduced percentage of Campylobacter positive flocks to 10.3% (untreated houses had a prevalence of 36%)	(Bahrndorff et al. 2013)
Financial incentive rewarding farm managers and stockpersons for each flock considered not highly contaminated with Campylobacter.	Reduced chance of a flock being highly contaminated with Campylobacter before slaughter by 54%	(Higham et al. 2018)
A commercial organic acid mixture (Selko®4Health) was added to drinking water at 0.075% for the entire rearing cycle.	Over 4 log10 cfu/g reduction in Campylobacter counts at day 42 of age, but no effect on post-chill carcass counts. Why? 3-5 log increase in Campy numbers due to FW of 8 (12g)-12 (18g) hrs.	(Jansen et al. 2014)
Immersion chilling at 0.5-1.1°C in water containing 5 ppm free chlorine	3.36 log cfu/mL carcass rinsate reduction, and reduction in prevalence from 68% to 25%. 2 log cfu/mL lower counts than on air-chilled carcasses.	(Demirok et al. 2013)
High-pH scalding at a mean temperature of 52.3°C and pH of 9.89	57% to 17% reduction in prevalence and 0.71 log cfu/mL carcass rinsate reduction compared to neutral-pH scalding.	(Berrang et al. 2011)

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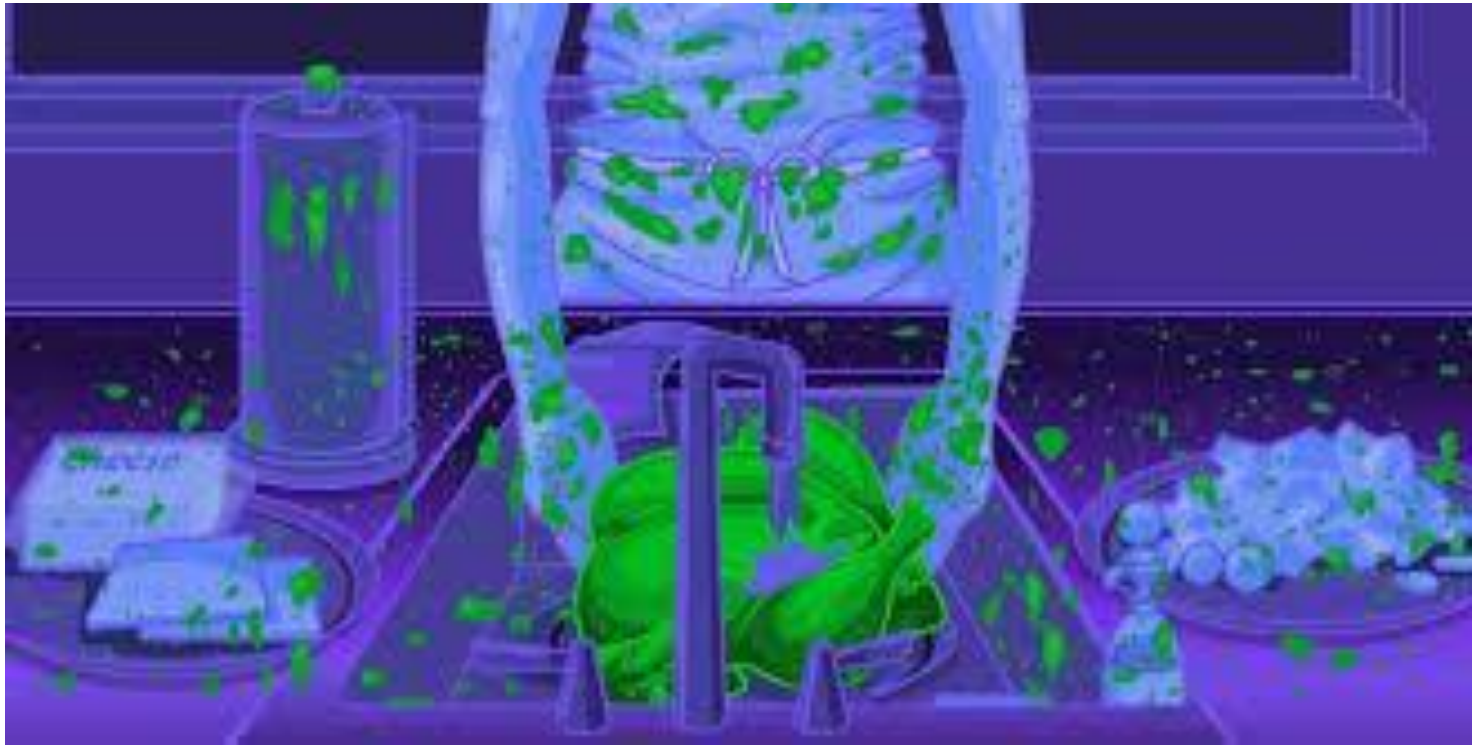
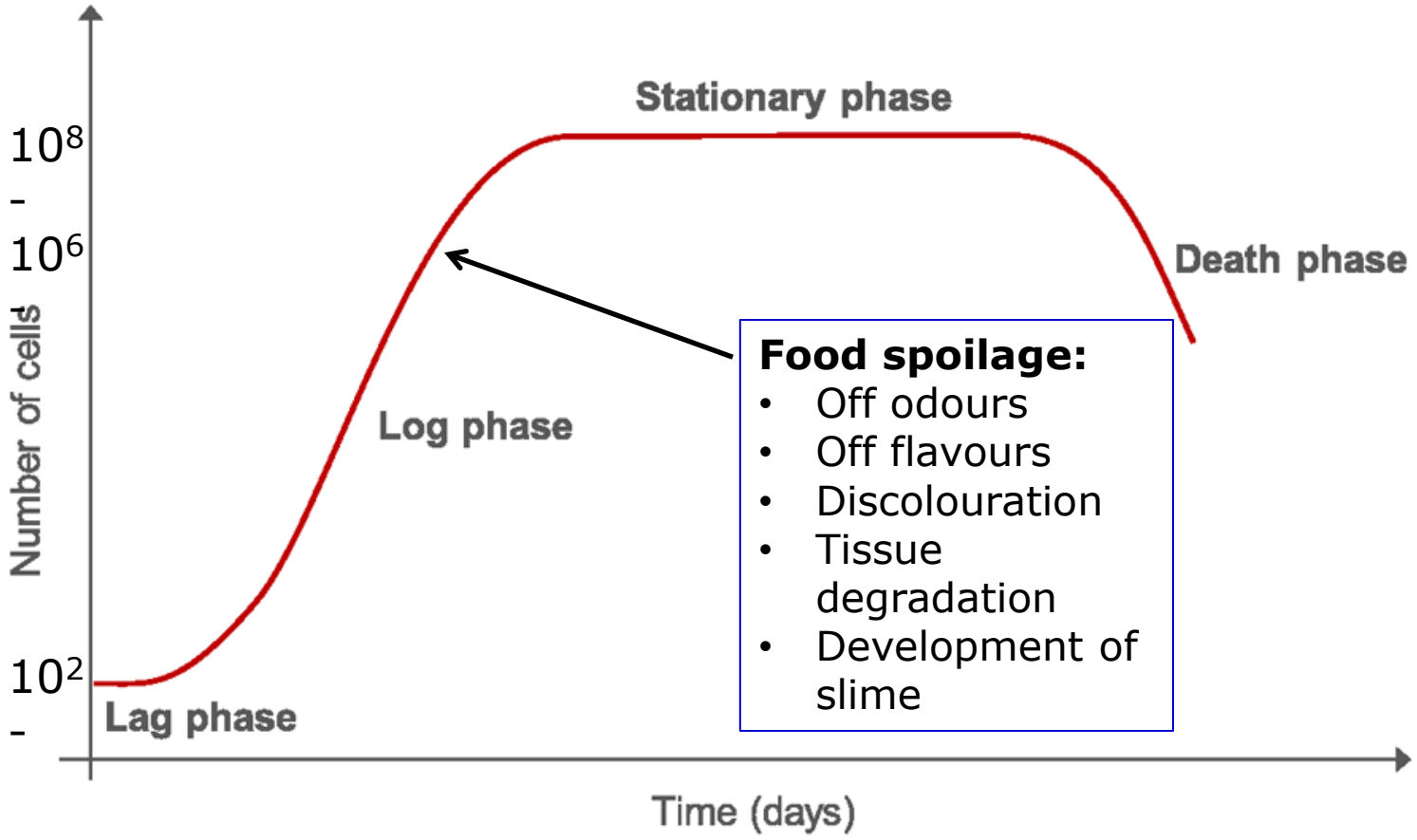
In home contamination



Source: Taylor, 2014, USDA

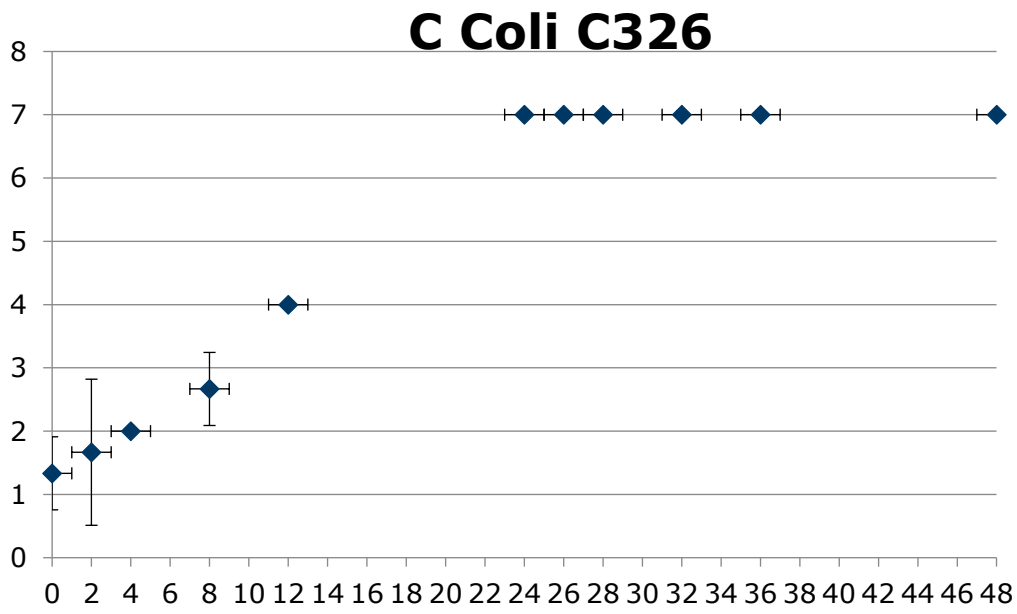
Consequences of microorganisms in foods

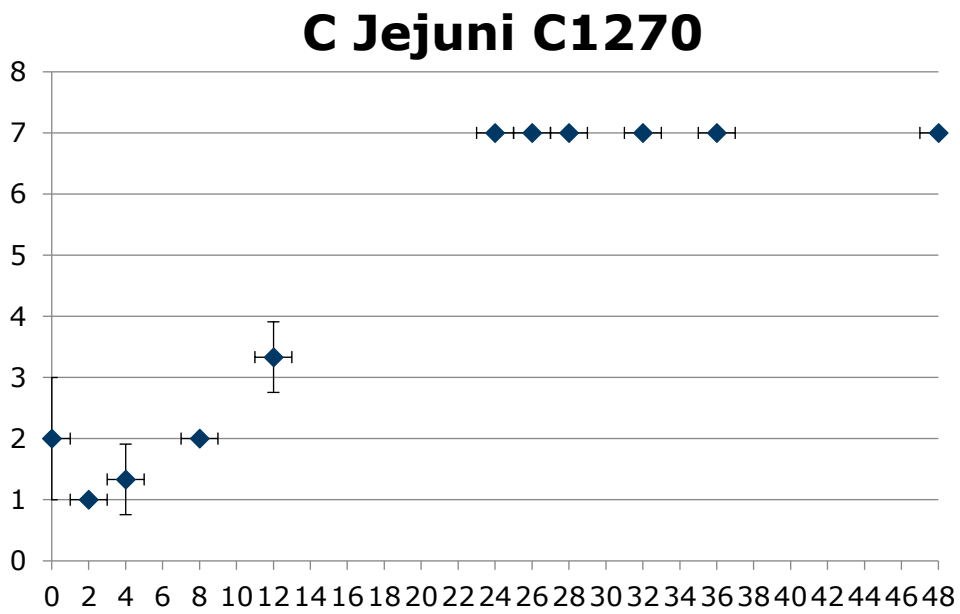


Food spoilage:

- Off odours
- Off flavours
- Discolouration
- Tissue degradation
- Development of slime

Growth curves of Campylobacter in Bolton's broth





- Bolton's broth inoculated with 10^2 cfu/ml of cells at time zero
- Cultures enumerated by mMPN at 2, 4, 6, 8, 10, 12, 24, 26, 28, 32, 36 and 48

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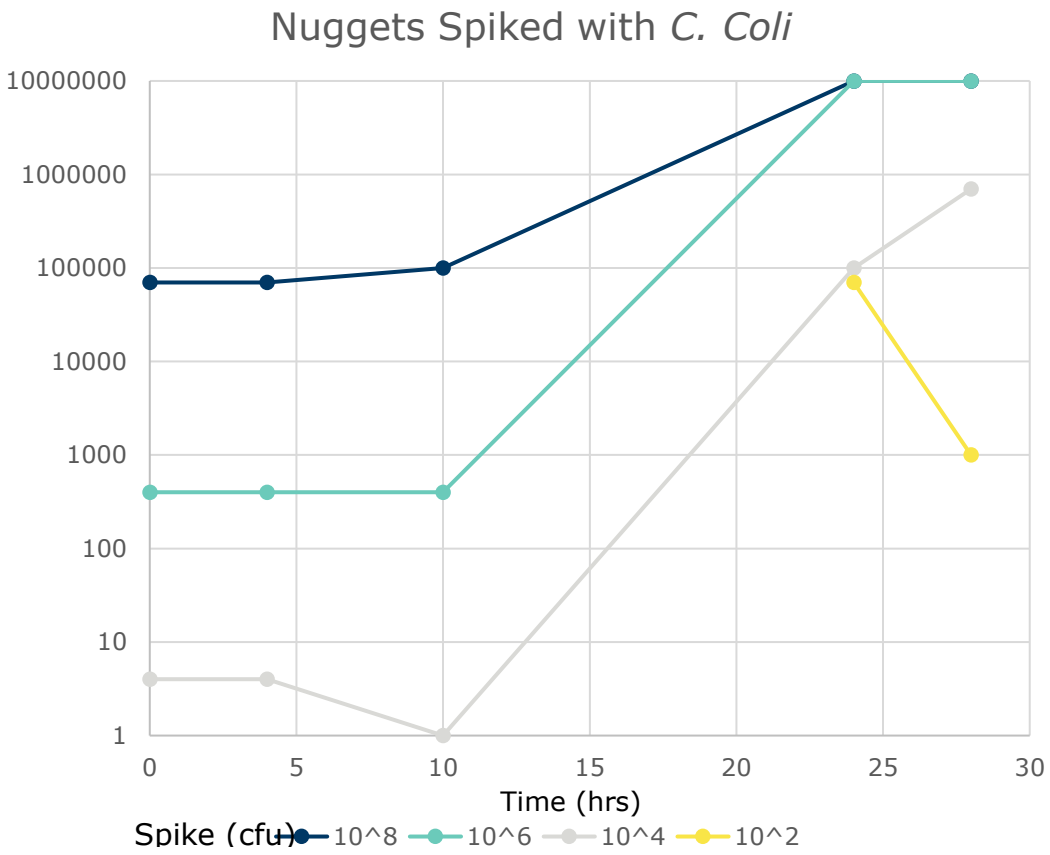

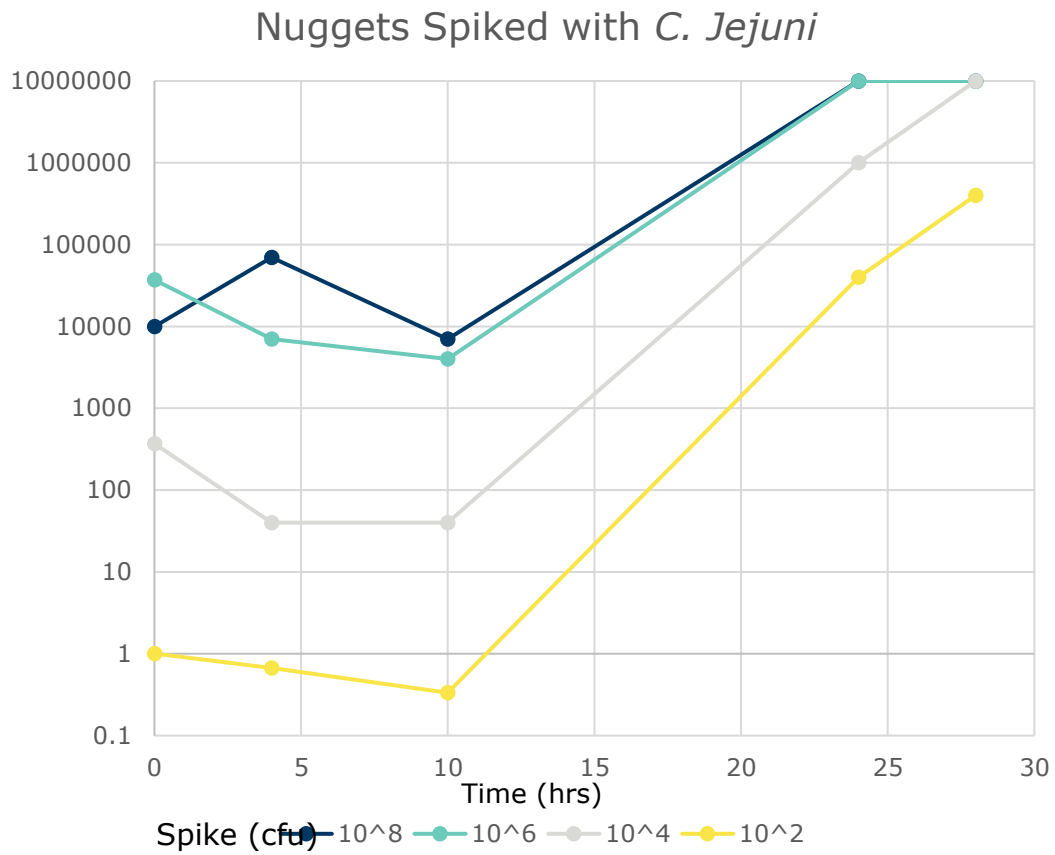

- Chicken Nuggets(25g) spiked with 10^8, 10^6, 10^4 and 10^2 cfu of Campylobacter, after 30min diluted 1:10 in Bolton's Broth.
- Samples enumerated in triplicate by mMPN at time 0, 4, 10, 24 and 28 hours
- Lag phase observed

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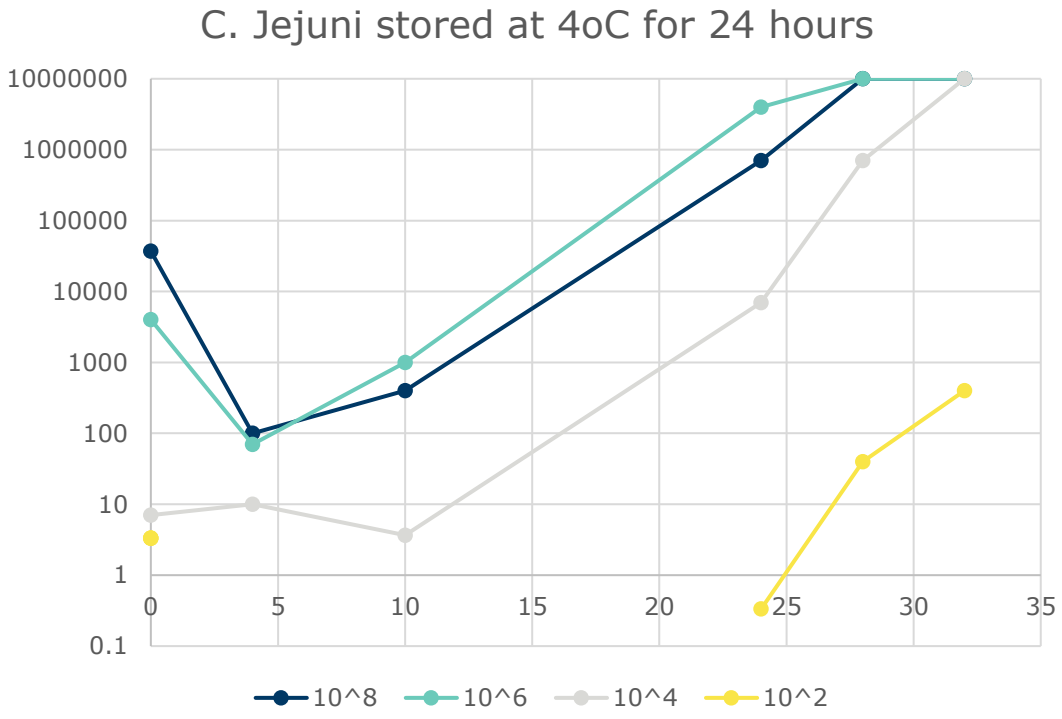

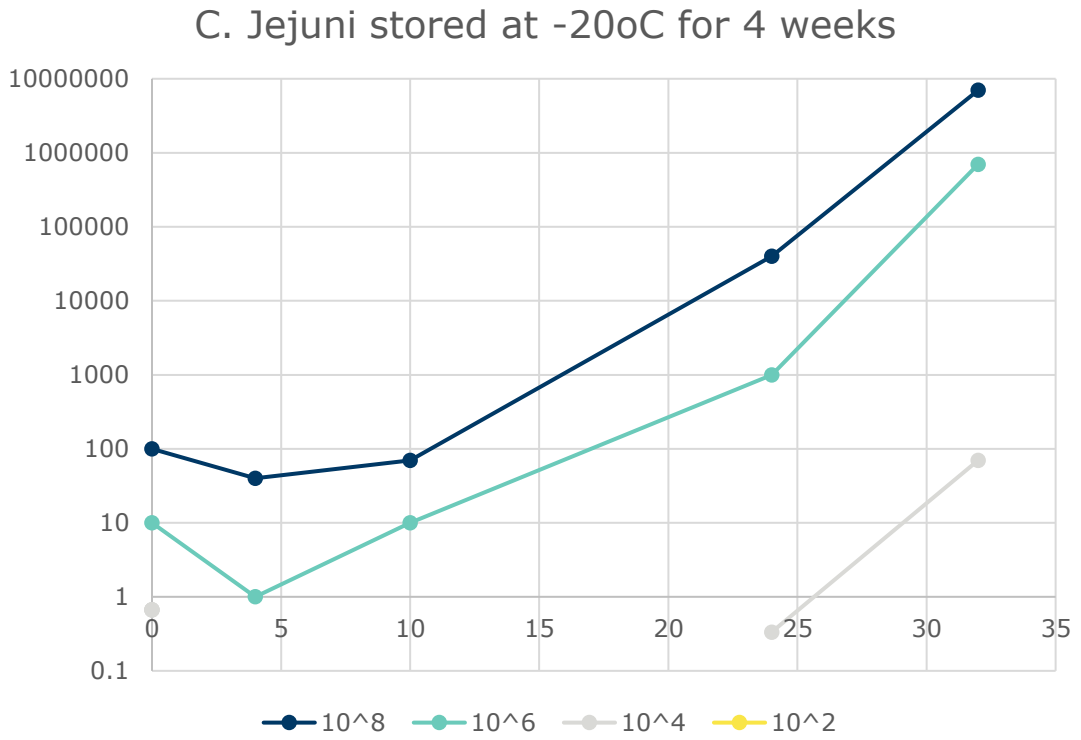

- Replicate samples were stored at 4oC for 24 hours and -20oC for 4 weeks
- Samples enumerated in triplicate by mMPN at time 0, 4, 10, 24, 28 and 32 hours
- Cold storage reduces Campylobacter viability
- Enrichment culture for at least 40hrs is required to detect low level contamination of food products

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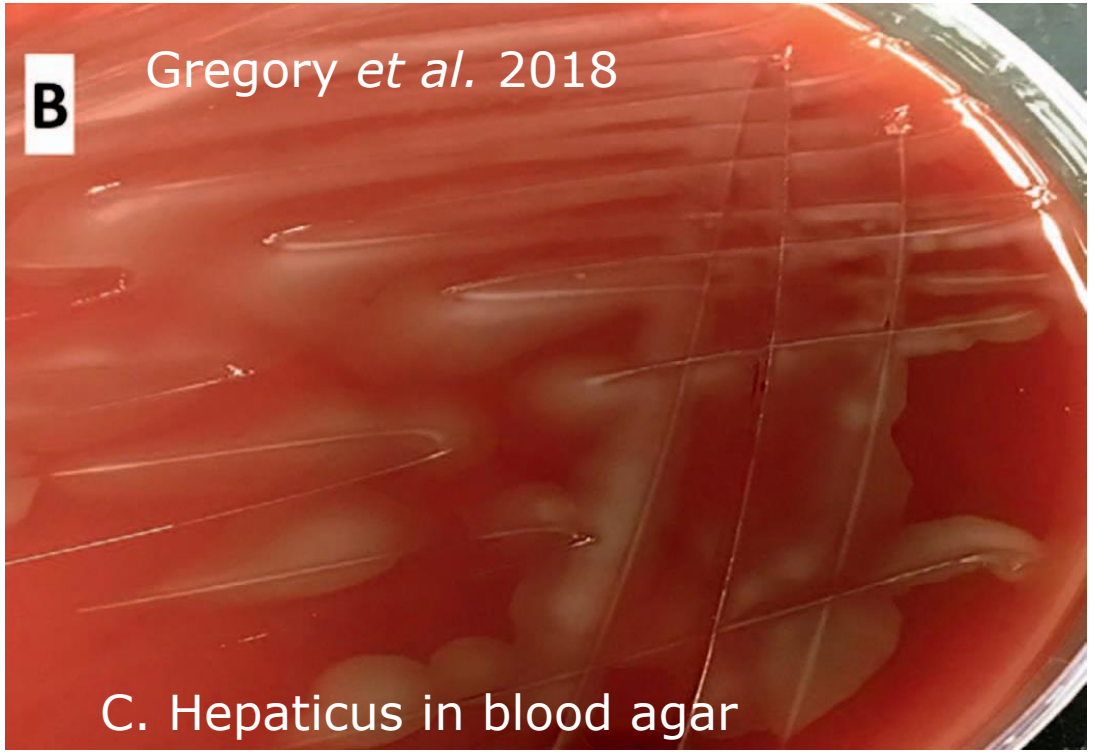
Campylobacter Hepaticus



- Fastidious growth habit, very sensitive to oxygen exposure
- Exists in a vibriod and coccoid forms, the vibriod (culturable form) is only present in the bile of infected birds

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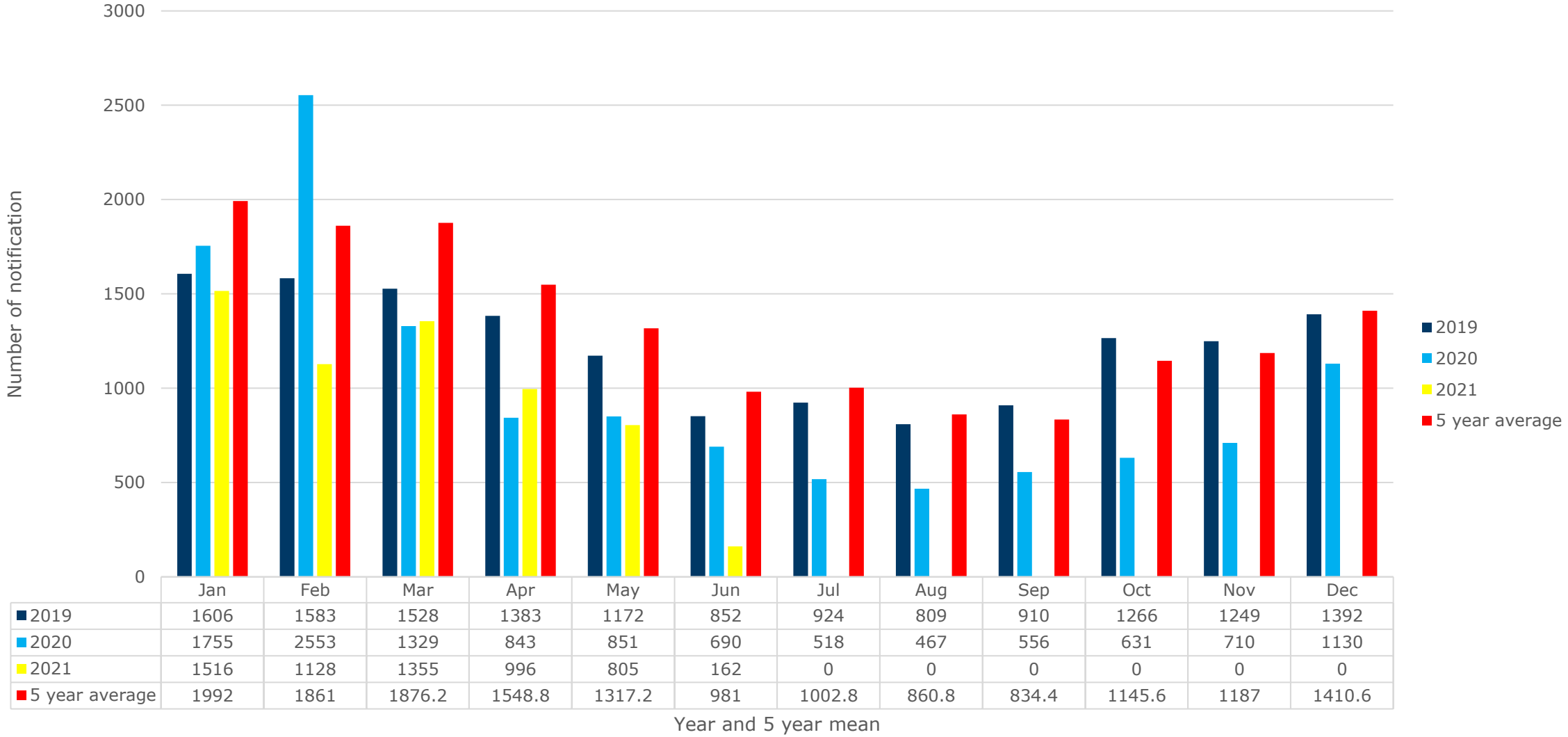
Has Covid19 affected Campylobacter and Salmonella cases???

National Salmonella notification (NNDSS health.gov.au)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	1606	1583	1528	1383	1172	852	924	809	910	1266	1249	1392
2020	1755	2553	1329	843	851	690	518	467	556	631	710	1130
2021	1516	1128	1355	996	805	162	0	0	0	0	0	0
5 year average	1992	1861	1876.2	1548.8	1317.2	981	1002.8	860.8	834.4	1145.6	1187	1410.6

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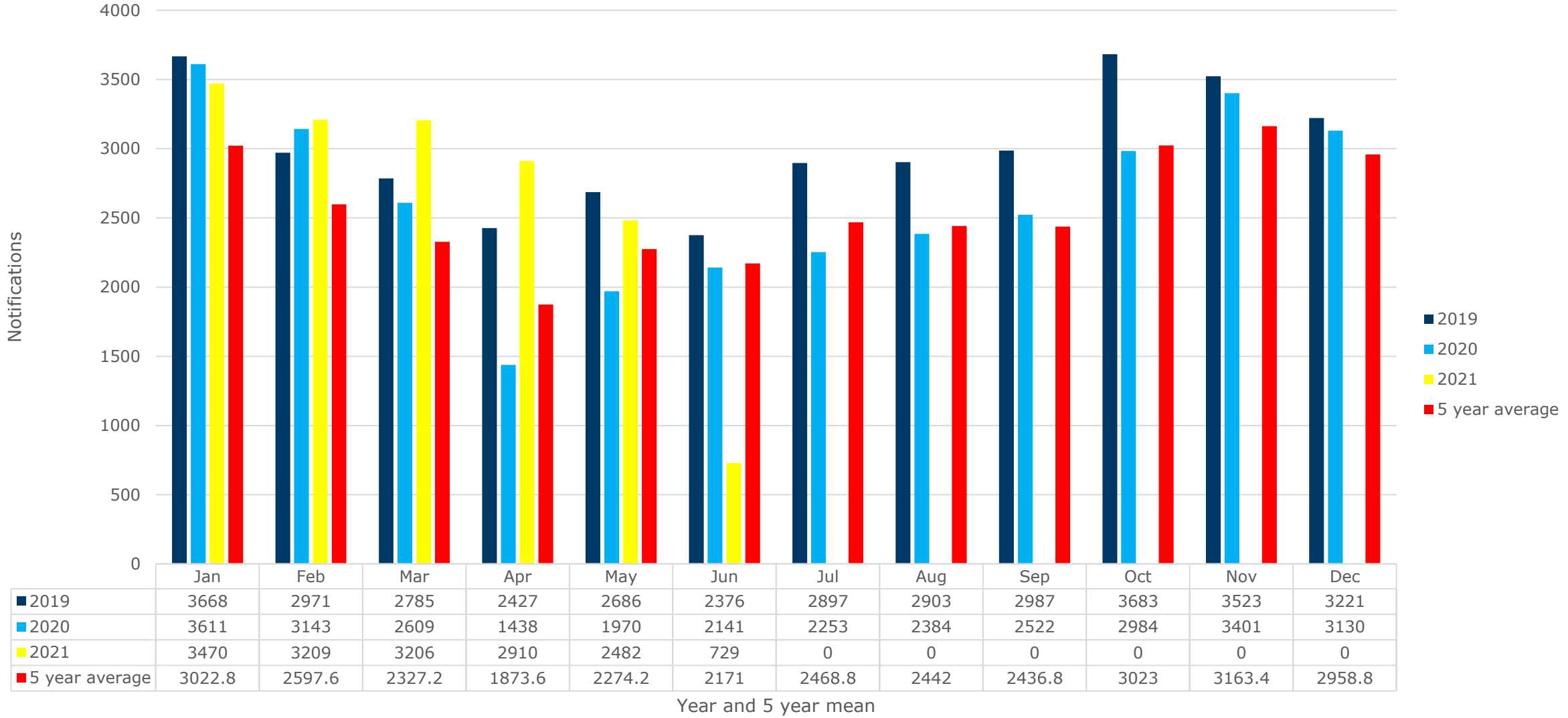
National Campylobacter notification (NNDSS health.gov.au)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	3668	2971	2785	2427	2686	2376	2897	2903	2987	3683	3523	3221
2020	3611	3143	2609	1438	1970	2141	2253	2384	2522	2984	3401	3130
2021	3470	3209	3206	2910	2482	729	0	0	0	0	0	0
5 year average	3022.8	2597.6	2327.2	1873.6	2274.2	2171	2468.8	2442	2436.8	3023	3163.4	2958.8

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Conclusion:

- Salmonella
  - > Pretty good grip on control with only variable being broilers.
  - > Sequential slaughter is an interesting avenue to explore.

- Campylobacter
  - > Need to establish mode of colonisation, either vehicle or vector.
  - > Lots of work required with through chain to understand and control.

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Thank you

Questions?

A moment of silence for all the samples that were lost
SKetching Science